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THE CENTIMETRE GRAMME SECOND AND THE CENTIMETRE DYNE SECOND SYSTEMS OF UNITS AND A NEW GRAVITATIONAL EXPERIMENT.

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THE C. G. S. system of units was undoubtedly a great advance over previous systems, but it has at least one serious disadvantage. This is the employment of the gramme as one of the fundamental units. Mass is not a fundamental conception, and has no claim to be put in the same class as length and time. We can conceive of matter as distinct from mass just as easily as we can conceive of matter as distinct from electricity, and far more logically, for each unit of matter is always associated with the same quantity of electricity, while the amount of mass associated with the unit of matter, *i. e.*, the atom, is more than 200 times as great in the case of some kinds of atoms as in others.

There is, therefore, this theoretical objection. There is also a practical one. Any system of units must be logical, in that the dimensional formula for any quantity must be made up of such concepts only as are necessarily associated with that quantity. This is not the case with the C. G. S. system. The dimensional formula for quantity of electricity in the electrostatic system of units is $L^{\frac{3}{2}} T^{-1} M^{\frac{1}{2}}$, in which the conception of mass is brought in. Now, mass has no connection with electricity, so far as we know at present; if there were no such thing as mass we should still have electricity, and therefore the system of units which gives such a formula is defective.

There is a second practical reason. This is, that in the C. G. S. system of units it is much more difficult to see readily relations between different quantities, and to interpret them, than in a more theoretically perfect one, on account of the fact that the M in the formula of a force which has no necessary connection with matter may cancel out with an M which has a legitimate right to be there For instance, suppose that, in working out a problem, we get such a result as M/T, this may mean almost anything, *i. e.*, it may be the product of various things, and what these are is not readily apparent.

As a matter of convenience, the writer has used a system of units in which the dyne takes the place of the gramme, and has found that there is a considerable advantage.

In this system the unit of mass drops back into its rightful place, and is a dimension of the same sort as the unit of electricity or the unit of magnetism. Gravity is treated as a separate substance, distinct from matter, but residing in it in the same way as magnetism is supposed to reside in iron, and unit quantity of gravity is defined as that quantity which will attract equal quantity placed at unit distance with unit force. The atomic weight of an atom is its permeability to gravity, and corresponds to μ in magnetism. Lines of gravitational force are supposed to radiate from a body charged with gravity in the same way as from a body charged with electricity or magnetism.

Current of gravity is the quantity of gravity which passes between any two points in unit of time, and unit of gravitational potential causes unit current of mass through unit resistance.

To show the advantage of the C. D. S. system over the C. G. S. system, the following table is subjoined, which gives the principal dimensional formulæ in Electricity, Magnetism, Heat and Gravity in both systems:

C. D. S. Units.	Gravity.	Mag.	Elec. Stat.	Elec. Mag.	Heat.
Quantity	$\sqrt{FL}$	$\sqrt{FL}$	$\sqrt{FL}$	$\sqrt{FL^2/T}$	FL
Current	$\sqrt{FL/T}$	$\sqrt{FL/T}$	$\sqrt{FL/T}$	$\sqrt{FL^2/T^2}$	FL/T
Difference of Pot	$\sqrt{F}$	$\sqrt{F}$	$\sqrt{F}$	$\sqrt{FT/L}$	1
Resistance	T/L	T/L	T/L	L/T	T/FL
Capacity	L	L	L	L^3/T^2	FL

C. G. S. Units.	Gravity.	Mag.	Elec. Stat.	Elec. Mag.	Heat.
Quantity	M	$\sqrt{L^3}\sqrt{M/T}$	$\sqrt{L^3}\sqrt{M/T}$	$\sqrt{L}\sqrt{M}$	L^2M/T^2
Current	M/T	$\sqrt{L^3}\sqrt{M/T^2}$	$\sqrt{L^3}\sqrt{M/T^2}$	$\sqrt{L}\sqrt{M/T}$	L^2M/T^3
Difference of Pot.	L^2/T^2	$\sqrt{L}\sqrt{M/T}$	$\sqrt{L}\sqrt{M/T}$	$\sqrt{L^3}\sqrt{M/T^2}$	1
Resistance	L^2/TM	T/L	T/L	L/T	T^3L^2M
Capacity	MT^2/L^2	L	L	L^3/T^2	L^2M/T^2

Incidentally, it may be noted that the notation is more concise. This, however, is merely an accidental point, the main thing being that the C. D. S. system is "ethically" more correct, and that it does not distort ideas so much in the handling as the C. G. S. system does.

It will be found convenient to denote the different quantities by means of subscript letters. Thus, R_g, R_m, R_{es}, R_{em}, R_h represent gravitational, magnetic, electrostatic, electromagnetic, and heat resistances. So, also, W_g represents gravitational work, *i.e.*, $1/2mv^2$, W_{em} represents electrical work, or C^2R, W_h represents heat energy, being really only a particular case of W_g, in which the algebraic sum of the vectors representing the velocities is zero, and W_m represents magnetic work, or B × M.M.F. One or two remarks may be made in regard to these formulæ. There has been some doubt in regard to the correct dimensional formula for temperature. This has been caused by the incorrect assumption that k, the specific heat of a body, is a number. That this is not the case follows from the law of Dulong and Petit. According to this, the atomic heat of all the elements is the same. Therefore, the heat required to raise a cubic centimetre of any substance one degree C., *i. e.*, its specific heat, is equal to the heat required to raise the temperature of a single atom the same amount × the number of atoms in the cube. This last is a number, and the former depends upon the kinetic energy of the atom. As the dimensional formula for kinetic energy is the same as that for work, *i. e.*, LF. (in the C. D. S. system), the formula for temperature must equal FL÷FL., *i. e.*, unity.

We obtain the same result by considering the fact that Quantity of Heat × Heat Potential must equal Work, *i. e.*, LF × heat potential=LF. A current of Heat, then, is a cur-